PROJECT FACT SHEET

CONTRACT TITLE: Increased Effectiveness of Hydraulic Fracturing

ID NUMBER: ACTI-091

B & R CODE: AC1005000

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PROJECT SITE
CITY: Albuquerque **STATE:** NM
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CONTRACT PERFORMANCE PERIOD:
02/01/1995 to 04/30/1998

PROGRAM: Supporting Research
RESEARCH AREA: Partnership/Computational Technology

FUNDING ($1000'S)	DOE	CONTRACTOR	TOTAL
PRIOR FISCAL YRS	389	825	1,214
FISCAL YR 1997	620	0	620
FUTURE FUNDS	0	0	0
TOTAL EST'D FUNDS	1,009	825	1,834

OBJECTIVE: To increase the effectiveness of hydraulic fracturing through the application of Sandia and industry expertise in the areas of proppant flow computation and modeling, visualization, mesh generation, and coupled integral equation.

METRICS/PERFORMANCE:

Products developed: Improved fracture design can significantly increase production and reduce costs. Since hydraulic fracturing is a major cost of completing an oil or gas well, reducing costs can dramatically improve the economics of oil and gas production in the US. Fracture design can be improved through the use of a numerical fracture simulator, such as TerraFrac, with which multiple scenarios can be analyzed to optimize the effect of the treatment and manage the risks of data uncertainties. The significant improvements in the design of hydraulic fracturing treatments that result from this project will substantially increase oil and gas production and will reduce costs. Improved 3-D hydraulic fracture simulator, TerraFrac was developed.

PROJECT DESCRIPTION:

Background: Hydraulic fracturing is the primary well stimulation technology for the recovery of gas and oil from low permeability reservoirs. Such reservoirs are of great importance in the U.S. and will become increasingly important world-wide as higher permeability reservoirs are depleted. While hydraulic fracturing has been remarkably successful in improving production from many wells, there are many cases in which production has been increased only slightly or not at all. Because of such uncertainty, and because the costs of hydraulic fracturing represents the major part of the well completion costs, significant improvements in the design of hydraulic fracturing treatments have great potential for increasing production and reducing costs. Hydraulic fracturing treatments are commonly designed using 2D or pseudo 3D models in which empirical assumptions are made regarding the modeling of the elasticity of the cracked formation and the flow of the fluid in the fracture. These assumptions tend to either underestimate or overestimate the fracture length, even for fractures that are confined to the payzone. Furthermore, they are incapable of investigating vertical migration of the fracture. The one-dimensional flow assumed in these models is inadequate for describing the flow of the proppant--whose placement is the objective of the treatment and the determining factor in the improved productivity of the well. Pseudo 3D models involve essentially the same approximations as the 2D models except that they allow for modest growth in the height of the fracture.

Three dimensional simulation of hydraulic fracturing was developed at TerraTek, Inc. beginning in 1978; the TerraFrac code was released in December, 1983. The initial version of TerraFrac included 3D elasticity, 2D flow, and linear elastic fracture mechanics. Over the years, new versions have been released as additional features have been added; e.g., thermal effects of fluid flow and proppant transport, thermal stresses, and poreoelastic effects. Capability for multiple fracture initiation ("limited entry") and for correlating fracture heights with temperature logs is currently being implemented. TerraFrac is licensed for use by companies in the gas and oil industry, including those named as participants in this proposal. TerraFrac is widely accepted as the standard to which approximate codes are compared.

Work to be performed: This project will increase the effectiveness of hydraulic fracturing through the application of computational technologies at Sandia, Los Alamos, the University of New Mexico, and TerraTek (the developer of the industry-leading, fully 3D fracture simulator, TerraFrac). In addition, the TerraFrac Users Group, consisting primarily of companies that have invested $1.6 million in the prior development of TerraFrac, will provide guidance, testing, and funding to the project. The project consists of tasks to extend simulation to horizontal drilling applications, including non-symmetric, non-planar fractures; to couple 3D fracture simulation to reservoir modeling; to improve the physical description of slurry flow; to develop a graphic user interface and advanced visualization capability; to implement Sandia's patented meshing algorithm; and to verify fracture simulation results with results from a new fracture mapping technology developed in a DOE/Gas Research Institute Funded project. Commercialization of project results is the responsibility of TerraTek.

PROJECT STATUS:

Current Work: First year tasks were completed on schedule and on budget. Second year tasks are ongoing.

Scheduled Milestones:

Initial TerraTek support contract placed	05/95
Contract with StimLab Proppant consortium signed	10/95
Project Review meeting for industrial partners	01/96
Integration of Sandia and TerraTek programming tasks	03/96
New version released to industry partners	06/96
Project on hold-no 1996 funds	06/96
Funding re-initiated	04/97
Second Terra Tek Support contract placed	05/97
New version to be released to industry partners	11/97
Project completed	04/98

Accomplishments: The user interface has been designed and implemented in AVS/Express, and includes extensive visualization capability. TerraTek received training on the use and maintenance of the user interface code. Results of boundary element simulation of particle settling rates shows that particles settle 3-5 times faster in flowing fluids than typical hindered settling formulas would predict. A settling algorithm was given to TerraTek for inclusion in their TerraFrac code. Sandia's patented PAVING meshing algorithm was licensed and transferred to TerraTek, and TerraTek has modified TerraFrac to utilize the new, robust, mushing technique.